

## TWO NEW SPECIES OF BLACK FLIES (DIPTERA: SIMULIIDAE) FROM NORTH AMERICA

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**Abstract.**—The larva, pupa, female, and male of two new species of black flies from North America are described and illustrated. *Simulium fionae*, new species, a member of the *S. vernum* group, is known from Pennsylvania and New Hampshire. *Simulium claricentrum*, new species, a member of the *S. pictipes* group, is known from Arkansas, Missouri, Oklahoma, and Pennsylvania. Characters are provided to separate both species from closely related Nearctic taxa.

**Key Words:** Simuliidae, *Simulium*, black fly, aquatic insect

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As of 1986, the North American simuliid fauna north of Mexico consisted of 162 formally recognized species (Crosskey 1987); one additional species has since been described (Adler 1987). In the present paper, I describe two new Nearctic species, one a member of the *Simulium vernum* group and the other a member of the *S. pictipes* group.

The taxonomic status of the Nearctic *S. vernum* group has been summarized by Adler (1987). Thirteen species have been described formally, and the chromosomes of at least three additional species have been resolved in terms of the *vernum* standard (Brockhouse 1985, Hunter and Connolly 1986). Here, I describe all life stages of one of these latter species, *Simulium* sp. of Hunter and Connolly (1986). In the *S. pictipes* group, two species have been described (Shewell 1959) and a third, described herein, has been known cytologically as *S. pictipes* "A" (Bedo 1973, 1975).

Procedure and nomenclature follow those used by Adler (1987), although measurements of adults of *S. sp.* were taken from alcohol-preserved specimens and of *S. pictipes* "A" from freeze-dried specimens. What previously were referred to as mandibular

teeth are differentiated in this paper as serrations and sensillum, following the terminology of Craig and Craig (1986). All illustrations and photographs are based on material collected at the type localities. Holotypes and some paratypes are deposited in the United States National Museum of Natural History, Washington, D.C. Additional paratypes are deposited in the Canadian National Collection, Biosystematics Research Centre, Ottawa (all chromosomal photographs are deposited here); the British Museum (Natural History), London; and the Clemson University Arthropod Collection, South Carolina.

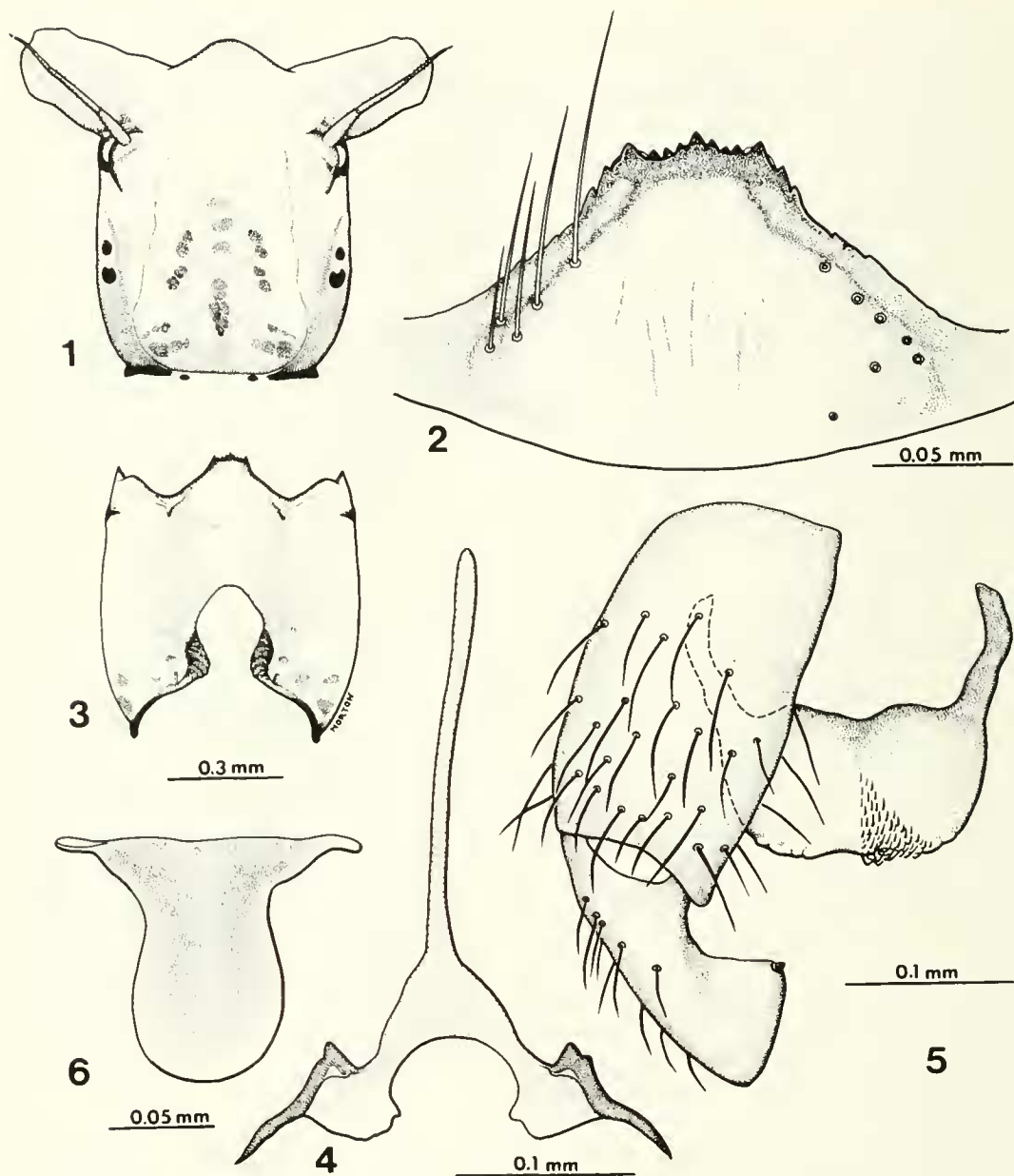
### *Simulium fionae* Adler, NEW SPECIES Figs. 1-9

*Simulium* (*Eusimulium*) *furculatum*, Adler, 1983, (not Shewell 1952): 197, pupa.

*Simulium* (*Nevermannia*) species near *furculatum/croxtoni* Adler & Kim, 1986: 29, larva, pupa.

*Simulium* sp. Hunter & Connolly, 1986: 300, chromosomes.

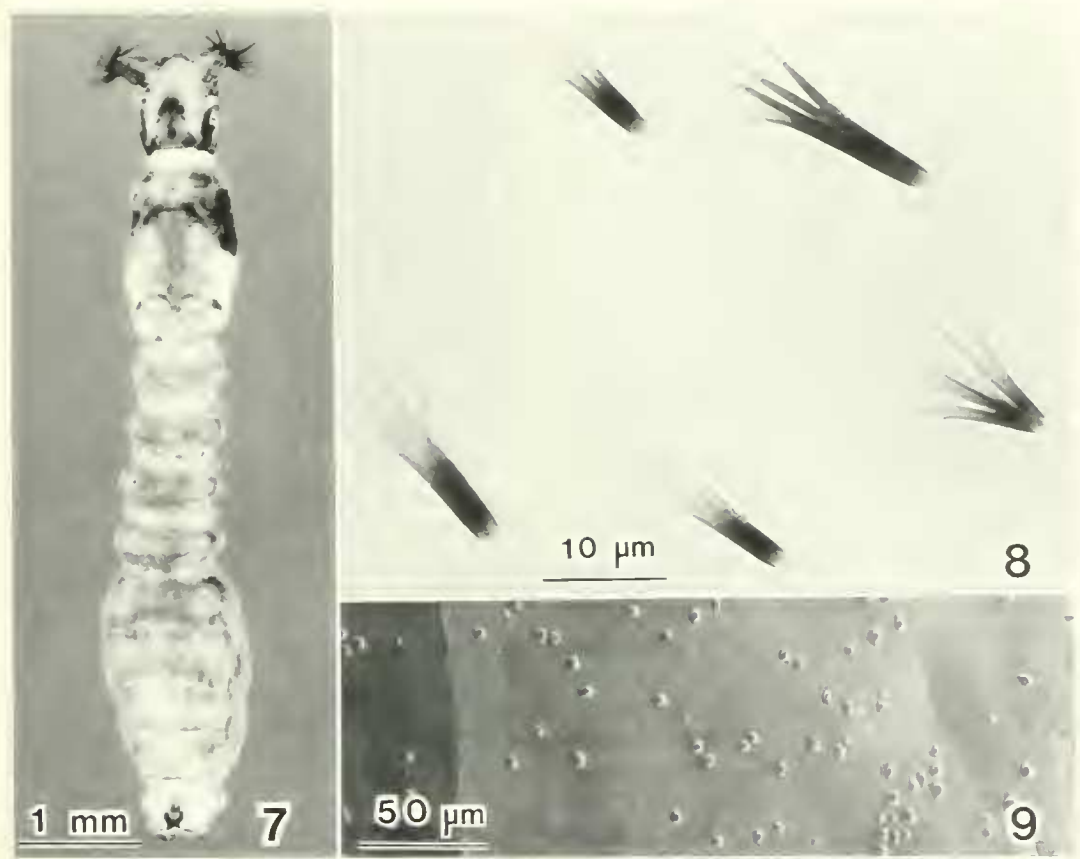
*Simulium* sp. near *croxtoni-furculatum* Hunter, 1987: 52, chromosomes.



Figs. 1-6. *Simulium fionae* new species. 1, Larval head capsule (dorsal view). 2, Larval hypostoma. 3, Larval head capsule (ventral view). 4, Female genital fork (sternite 9). 5, Male terminalia (ventral view with left gonocoxite, gonostylus, and parameres removed). 6, Male dorsal plate.

Larva (final instar).—Length 6.3–7.5 mm ( $\bar{x}$  = 6.8 mm,  $n$  = 47). Head capsule (Fig. 1) pale yellowish brown, palest anterodorsally, covered with numerous, fine, pale,

simple setae (visible with phase contrast); headspots brown, distinct, delineating infuscated area; eye spots rather large; line over eye spots brown, leading into heavy



Figs. 7–9. *Simulium fionae* new species. 7, Larval habitus (dorsal view). 8, Larval cuticular setae (from dorsum of segment 7), as viewed with bright-field compound microscope. 9, Scanning electron micrograph of granules on portion of pupal thorax (dorsal view); ecdysial line is apparent on the left side.

brown area posteriorly. Antenna with distal article faintly brown, median article translucent or very pale yellowish brown dorsally, proximal article pale yellowish brown; approximately  $\frac{1}{3}$ – $\frac{1}{2}$  of distal article surpassing labral-fan stalk; proportions of articles (distal to proximal, excluding apical sensillum) approximately 1.0:1.3:1.0. Labral fan with 41–51 ( $\bar{x}$  = 46,  $n$  = 45) primary rays in New Hampshire specimens [35–40 ( $\bar{x}$  = 37,  $n$  = 2) in Pennsylvania specimens]. Hypostomal teeth (Fig. 2) with median tooth and lateral teeth subequal in length and prominence; sublateral teeth variously smaller; lateral margin of hypostoma with 2 paralateral teeth and 2–5 lateral serrations per side; hypostoma with 2–3 prominent

and 2–5 small lateral setae per side. Postgenal cleft (Fig. 3) about 1.3–1.5 times as long as wide, extending about  $\frac{1}{2}$ – $\frac{3}{5}$  distance to hypostomal groove, widest at midpoint, rounded apically; subesophageal ganglion unpigmented. Maxillary palpus 2.8–3.5 times as long as basal width. Inner subapical ridge of mandible with double or triple sensillum proximal to 1 elongate serration. Lateral plate of thoracic proleg moderately sclerotized, rather broad, elongate, extending almost entire length of apical article. Body (Fig. 7) reddish brown; intersegmental bands clear, distinct; ventral tubercles rounded, about  $\frac{1}{3}$  depth of abdomen at attachment points; abdominal segments 4–8 (sometimes 5–8) dorsally and laterally with

many short, multiply branched, dark brown setae (Fig. 8), ventrally with similar but much sparser dark brown setae; thoracic and remaining abdominal segments with many shorter, multiply branched, translucent setae (visible with phase contrast). Antero-dorsal arms of anal sclerite broadly connected to and subequal in length to posteroventral arms, associated with elongate, translucent, simple setae (visible with phase contrast). Rectal setulae pale, sparse (visible with phase contrast). Posterior proleg bearing 9–12 hooks in 61–64 rows. Anal papillae of 3 compound lobes.

**Pupa.**—Length 3.1–3.9 mm ( $\bar{x}$  = 3.4 mm). Head projecting downward, with numerous, minute, rounded granules; antennal sheath of female extending almost to posterior margin of head; antennal sheath of male extending about  $\frac{1}{2}$  distance to posterior margin of head. Gill (Fig. 58 in Adler and Kim 1986) about as long as pupa, consisting of 8 rather widely splayed filaments; base short, giving rise to 3 short petioles; dorsalmost petiole giving rise to 2 widely divergent filaments; lateral petiole giving rise to a single lateral (or ventral) filament plus a dorsal pair on a petiole 1–5 times its basal width (rarely sessile); ventral petiole yielding a single lateral filament plus a ventral pair on a petiole 1–6 times its basal width (rarely sessile); filaments grayish, long, thin, tapering, with numerous furrows; surface sculpturing of base weakly differentiated. Thorax (Fig. 9) with numerous, minute, dome-shaped granules; trichomes simple (some occasionally bifid), slender, dark, 5–6 on each side of thorax. Tergite I with 1 pair of setae; tergite II with 5–6 anteriorly directed setae on each side of midline, and 1–2 minute setae laterally; tergites III and IV each with 4 anteriorly directed hooks on posterior margin on either side of midline, 1 small seta between and anterior to 2 outermost hooks, and 2–3 small setae laterally; tergites V to VIII each with row of fine, posteriorly directed spines along anterior margin, and 2–3 minute setae posteriorly on either side of midline; tergite IX with

pair of short, stout, slightly curving, dorsally directed terminal spines. Pleural membrane of segments II to VII usually with 1–3 minute setae per side. Sternite III with about 3 minute setae per side; sternite IV posteriorly with pair of closely set, moderately heavy, simple or bifid, anteriorly directed setae, and at least 2 fine, minute setae per side; sternite V posteriorly with 1 pair of closely set, anteriorly directed, multifid, hook-like setae, and at least 1 pair of fine setae per side; sternites VI and VII posteriorly with 1 pair of distantly set, anteriorly directed, simple to trifid, hook-like setae, and at least 1 pair of fine setae per side; sternites VIII and IX with at most 1 pair of fine setae; sternites IV to VIII with numerous, extremely fine microspines. Cocoon (Fig. 41 in Adler and Kim 1986) well formed, rather coarsely woven, with short, irregularly woven anterodorsal projection accounting for about 4.6–13.9% ( $\bar{x}$  = 9.3%,  $n$  = 9) total cocoon length (in lateral view).

**Female.**—General body color brown, with gray pruinosity, and silvery and pale golden pile. Length: body, 2.9–3.2 mm ( $\bar{x}$  = 3.0 mm,  $n$  = 5); wing, 3.1–3.3 mm ( $\bar{x}$  = 3.2 mm,  $n$  = 3).

Frons at vertex about 1.5–2.0 times broader than at narrowest point, about  $\frac{1}{2}$  width of head, with decumbent and erect, sparse, mixed silver and brown pile. Clypeus about as long as wide, with sparse silvery pile. Occiput with silvery pile reaching posterior margin of eye; postocular setae black. Antenna with fine silver pubescence; first flagellomere longest; pedicel and scape light brown; flagellum brown. Mandible with 41–45 serrations. Lacinia with 31–32 retrorse teeth. Palpus dark brown, with stout, pale golden setae; palpomere V 1.7–2.0 times as long as III. Sensory vesicle elongate, located posteriorly to subcentrally, occupying about  $\frac{1}{2}$  of palpomere III; neck short, arising near anterodorsal margin, opening to exterior through rounded, slightly expanded mouth. Median proximal space of cibarium broadly U-shaped, lacking armature.

Postpronotum and proepisternum brown,



with long silvery pile. Scutum dark brown, humeral angles light brown; pile recumbent, golden centrally, silvery peripherally. Scutellum dark brown, with long, very pale golden pile mixed with black setae. Postnotum dark brown. Anepisternum and katapisternum dark brown; katapisternum with a small, ventral patch of silvery pile (often rubbed off); membrane and mesepimeron brown; mesepimeral tuft of long, silvery setae. Wing veins pale yellowish brown. Setae on stem vein and costal base dark brown, with bronze reflections; setae on other veins primarily brown; subcosta setose ventrally; fringes of calypter and alar lobe silvery. Halter tan, with line of pale golden pile. Coxae and tarsi dark brown; femora and tibiae brown; pile on legs silvery to pale golden; hind basitarsus 6.5–7.3 times as long as broad; calcipala and pedisulcus well developed; claws each with large, thumb-like lobe.

Abdominal sclerites dark brown; pile sparse, silvery; additional sparse, long, black setae on terminal tergites; membranous areas gray to brown, with silvery pile. Basal fringe of long, silvery to very pale golden pile. Anal lobe subquadrate in lateral view, rounded anteriorly, with acute posterodorsal extension. Cercus a broadly rounded triangle, about 1.2–1.8 times as broad as long. Hypogynial lobes subtriangular, with space between lobes forming a narrow rectangle. Genital fork (Fig. 4) with stem moderately long and slender; lateral arms rather broad basally, forming suboval space in region of bifurcation; posteromedial areas of lateral arms well developed, and with bluntly acute angles; anteromedial area produced anteriorly. Spermatheca over 1.5 times as long as broad, with superficial pattern of subequal polygons.

Male.—General body color velvety black, with gray pruinosity and golden pile. Length: body 3.0–3.3 mm ( $\bar{x}$  = 3.1 mm); wing, 2.7–2.9 mm ( $\bar{x}$  = 2.7 mm).

Frons and clypeus with erect, brown pile. Occiput with long, erect, brown pile. Antenna dark brown, with fine, light brown pile. Palpus dark brown, with brown pile;

palpomere V about twice as long as palpomere III. Sensory vesicle subspherical, about  $\frac{1}{6}$  length of its segment, located posteriorly; neck rather short, slender, opening to exterior through small, rounded mouth.

Postpronotum and proepisternum brown, with silvery to pale golden pile. Scutum velvety black, with recumbent, golden pile. Scutellum dark brown, with bronze pile. Postnotum dark brown. Anepisternum, katapisternum, membrane, and mesepimeron dark brown, latter two sometimes paler; katapisternum bare; mesepimeral tuft of long, brown pile with bronze reflections. Wing veins pale yellowish brown. Setae on stem vein and costal base dark brown; setae on other veins brown; fringes of calypter and alar lobe brown with bronze reflections. Halter dark brown basally, paler distally, with bronze pile. Legs dark brown, with midsections of femora and tibiae paler; pile brown and golden brown, sometimes silvery on forecoxa. Hind basitarsus 5.3–6.0 times as long as broad.

Abdominal tergites velvety black, paler along posterior margins, with bronze pile; membranous areas gray, with bronze pile; sternites dark brown, with bronze pile. Basal fringe of very long, bronze pile. Terminalia as in Fig. 5. Gonocoxite about as long as broad. Gonostylus about as long as gonocoxite, about 2.9 times as long as breadth at midpoint, expanded apically into flattened, subtriangular, medially directed flange bearing 1 apical spine. Ventral plate in ventral view subrectangular, about twice as broad as long, slightly narrowing posteriorly, with posterolateral corners well rounded, and posterior margin medially produced as a small, hirsute tubercle; anterior margin with slight, medial concavity; arms directed slightly outward, with apices bowed slightly inward; lip in terminal view pronounced, broadly rounded, serrate laterally; median sclerite long, slender, forked for about  $\frac{1}{4}$ – $\frac{1}{3}$  its length; dorsal plate (Fig. 6) well sclerotized, with broad collar-like base, suborbicular distally; paramere in lateral view moderately narrow basally, broad-

ening medially, and bearing 1 long, slender, strongly sclerotized spine-like process.

Chromosomes (from larval salivary glands; inversions are relative to the *S. vernum* standard of Brockhouse [1985], Hunter and Connolly [1986]; 20 preparations examined by Hunter and Connolly [1986] from Pennsylvania, 20 preparations examined from New Hampshire).— $n = 3$ ; chromocenter present; B chromosomes lacking; IS with inversions *IS-1*, *IS-4*, and *IS-5*; IL with inversions *IL-2*, *IL-3*, *IL-4*, *IL-6*, and *IL-7*, and with secondary nucleolar organizer (section 41C-42B) generally expressed; IIS standard for *vernum* sequence; IIL complexly rearranged (Fig. 18 in Hunter and Connolly 1986); IIS with inversion *IIS-2*; IIL with inversions *IIL-4*, *IIL-5*, *IIL-6*, and *IIL-8*; sex chromosomes differentiated as  $Y_1 = IIL-1$  *sp*,  $X_0 = IIL$  standard; floating inversions in all arms except IIS.

Types.—Holotype: ♂ (pinned) with pupal and larval exuviae (in glycerin), outlet, Two-Towns Pond, Dixville Notch (The Balsams), Coos County, New Hampshire (44°52'N, 71°18'W), 24 May 1988, collected by P. H. Adler. Paratypes: NEW HAMPSHIRE: COOS COUNTY: same data as holotype, 77 larvae (including 40 mature), 10 chromosome preparations (8 female larvae, 2 male larvae) with photographic negatives, 15 pupae, 1 pupal exuviae, 4 ♂ (pinned) with larval and pupal exuviae (in glycerin), 1 ♂ (cleared, in glycerin), 3 ♀ (pinned) with larval and pupal exuviae (in glycerin); same data as holotype, 19 May 1987, 2 larvae, J. F. Burger; same data as holotype, 26 May 1987, 8 larvae, 4 chromosome preparations (3 female larvae, 1 male larva) with photographic negatives, J. F. Burger; outlet, beaver pond no. 5, Dixville Notch (The Balsams), 20 May 1987, 1 larva, 1 chromosome preparation (female larva) with photographic negatives, J. F. Burger; PENNSYLVANIA: MONROE COUNTY: outlet, White Heron Lake, Rt. 402, 1.6 km north

of Marshalls Creek (town), 7 May 1983, 4 larvae, 1 pupa, P. H. and C. R. L. Adler.

Additional specimens examined.—PENNSYLVANIA: MONROE COUNTY: pond outlet, Pocono Highland Camp, Rt. 402, 4.8 km north of Marshalls Creek (town), 7 May 1981, 1 pupa, G. E. Jones; NEW HAMPSHIRE: COOS COUNTY: outlet, Round Pond, Dixville Notch (The Balsams), 9 June 1988, 4 larvae, J. F. Burger.

An additional 83 males (68 pinned with exuviae in glycerin, 15 in alcohol with exuviae) and 43 females (34 pinned with exuviae in glycerin, 9 in alcohol with exuviae) were examined from the type locality (same data). Based on the configuration of the pupal gill, these specimens appear to be *S. fionae*. However, because pupal characters exhibit overlap between *S. fionae* and *S. croxtoni* and because the larval cuticle did not remain associated, I labeled the specimens as *Simulium croxtoni/fionae*.

Etymology.—This species is named in honor of Fiona F. Hunter who originally resolved the chromosomes of this species, and who has contributed significantly to a cytological understanding of the *S. vernum* group.

Diagnosis.—The larva of *S. fionae* is easily distinguished by the dark, multiply branched setae covering the posterior 4 or 5 abdominal segments. Larvae of the closely related and morphologically similar *S. croxtoni* Nicholson and Mickel possess dark, simple abdominal setae and generally have a longitudinal, pale brown stripe on the frontoclypeal apotome. Larvae of *S. furculatum* Shewell have simple setae and some scattered, multiply branched (mainly bifid) setae. The pupal gill of *S. fionae* is generally darker and more splayed than in *S. croxtoni* and *S. furculatum*, and the single filament of the ventral petiole typically arises lateral to the doublet, whereas in *S. croxtoni* the doublet often arises lateral to the single filament. The anterodorsal projection of the

cocoon is often shorter than in *S. croxtoni*. No reliable characters have been found to distinguish females of *S. fionae* and *S. croxtoni*. In *S. fionae*, the ventral plate of the male is slightly broader and less tapered than in *S. croxtoni*.

Chromosomally, *S. fionae* differs from the *S. vernum* standard by approximately 23 fixed inversions, and from all other known species by at least one fixed inversion in every arm except IIS (Hunter and Connolly 1986). It is most readily distinguished by a chromocenter in combination with a subterminal Z marker (section 32A–32B) and a reoriented blister group (sections 75C–76A), relative to standard. Populations in New Hampshire and Pennsylvania both carry IL-1 *sp.*, IIL-1 *sp.*, IIL-2 *sp.*, and the simple Y-linked inversion IIL-1 *sp.* Larvae from New Hampshire sporadically carry a small inversion in the middle of IS, two independent inversions in IIS (approximate limits 52–54 inclusive and 50–52C inclusive), and a subterminal inversion in IIL (approximate limits 71B–72C2 inclusive). Additionally, the majority (85%,  $n = 20$ ) of New Hampshire larvae carry at least one of five inversions in IL.

Biology.—*Simulium fionae* was collected from the outlets of two man-made impoundments in Pennsylvania and from the outlets of two beaver ponds and one man-made impoundment in New Hampshire. In Pennsylvania, larvae and pupae were collected in early May from old cattail (*Typha*) leaves and stalks trailing in the water. In New Hampshire, immatures were found from mid-May to early June almost exclusively on the undersurfaces of stones and sticks. At all sites, immatures were found with *Cnephia dacotensis* (Dyar and Shannon), and were restricted to within 20 m of the outlet. Stream temperatures at the time of collection ranged from 16.5 to 17°C, and stream widths ranged from 0.6 to 1.2 m. Nearly 12% of the larvae collected at the Two Towns Pond outlet were infected with

mermithid nematodes; one larva was infected with the fungus *Coelomyxidium simulii* Debaisieux while another was infected with an unidentified microsporidium.

### *Simulium claricentrum* Adler,

#### NEW SPECIES

Figs. 10–17

*Simulium pictipes* “A” Bedo, 1973: 12, chromosomes.

*Simulium* “species A” Reisen, 1974a: 19, ecology.

(*Hagenomyia*) “species A” Reisen, 1974a: 72, larval biology.

*Simulium* “species A” Reisen, 1974b: 275, larval biology.

*Simulium* (*Shewellomyia*) “species A” Reisen, 1975a: 949, larval biology.

*Simulium* “sp. a.” Reisen, 1975b: 27, larval biology.

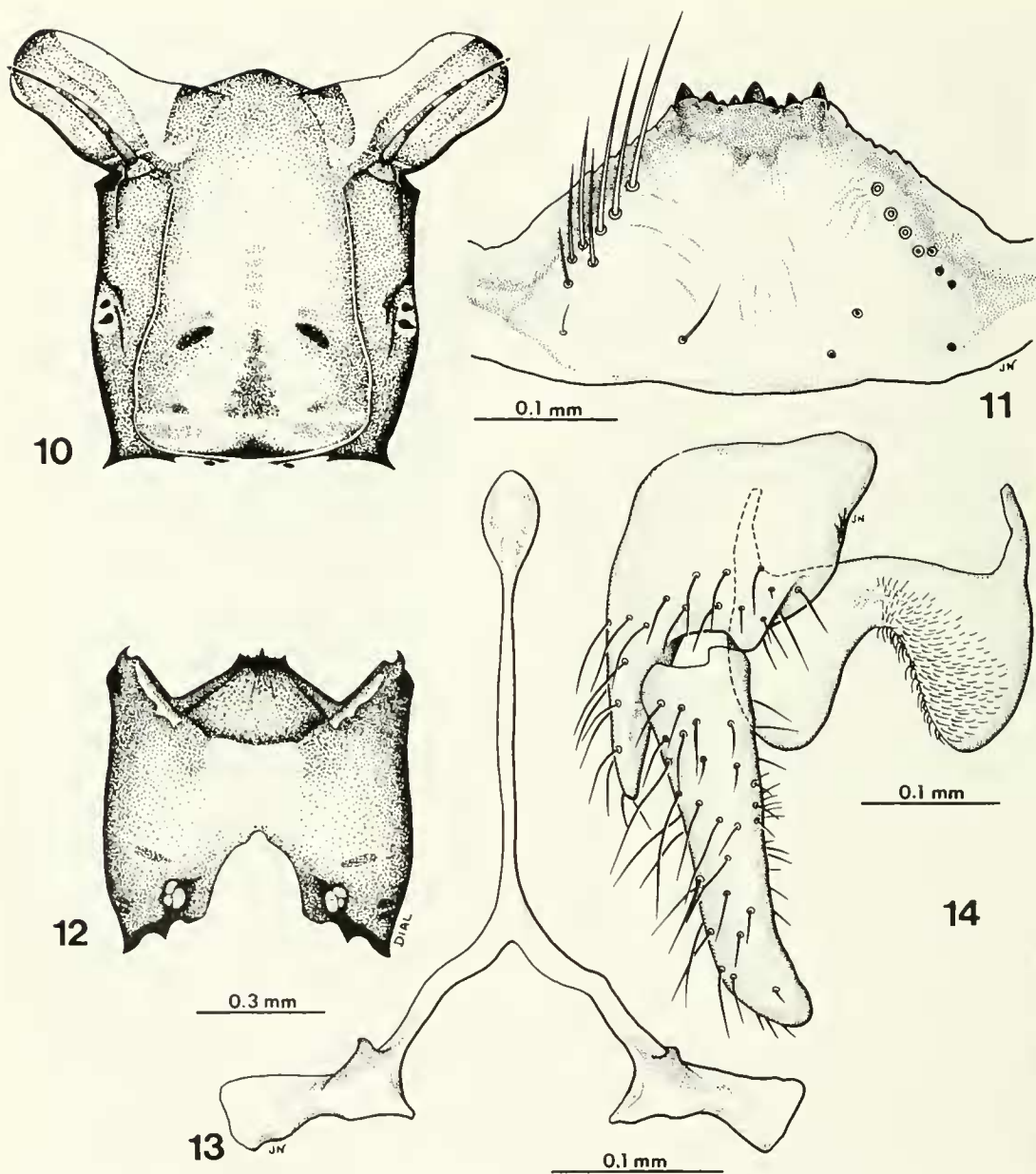
*Simulium pictipes* “A” Bedo, 1975: 1150, chromosomes.

*Simulium* (*Shewellomia*) [sic] “species A” Reisen, 1977: 325, larval ecology.

*Simulium* (*Shewellomyia*) *pictipes* “cyto-species A” Adler and Kim, 1986: 36, larva.

Larva (final instar).—Length 7.2–9.9 mm ( $\bar{x} = 8.5$  mm,  $n = 47$ ). Head capsule (Fig. 10) whitish yellow to brown with pale areas centrally and anteriorly on frontoclypeal apotome; pigmentation beneath cuticle often visible as dark reticulate pattern; headspots indistinct, or with anterolateral, posterolateral, and/or posteromedian headspots brown, fairly distinct; eye spots rather large; line over eye spots thin, brown. Antenna with distal article brown, median article pale brown (hyaline band visible subapically in darker specimens), proximal article pale brown; apex of distal article reaching end of labral-fan stalk; proportions of articles (distal to proximal, excluding apical sensillum) approximately 1.0:1.7:1.0. Labral fan with 47–60 ( $\bar{x} = 54$ ,  $n = 45$ ) primary rays. Hypostomal teeth (Fig. 11) with median tooth and lateral teeth relatively large; me-



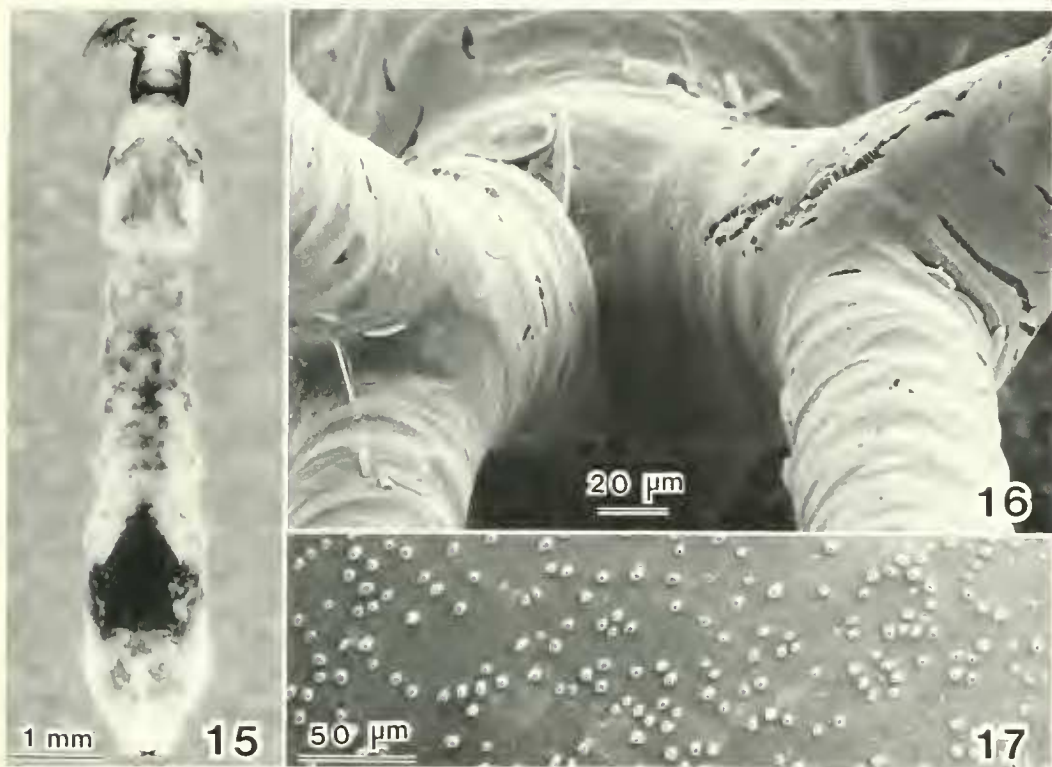


Figs. 10–14. *Simulium claricentrum* new species. 10, Larval head capsule (dorsal view). 11, Larval hypostoma. 12, Larval head capsule (ventral view). 13, Female genital fork (sternite 9). 14, Male terminalia (ventral view with left gonocoxite, gonostylus, and parameres removed).

dian tooth longest; outermost sublateral teeth shorter than lateral teeth, but longer than innermost sublateral teeth; median sublateral teeth shortest; lateral margin of hypostoma with 0–2 small paralateral teeth

and 3–4 lateral serrations per side; hypostoma with 6–7 prominent setae and 1–2 small lateral setae per side. Postgenal cleft (Fig. 12) about as long as basal width, extending about  $\frac{1}{2}$  distance to hypostomal





Figs. 15–17. *Simulium claricentrum* new species. 15, Larval habitus (dorsal view). 16, Scanning electron micrograph of base of pupal gill. 17, Scanning electron micrograph of granules on portion of pupal thorax (dorsal view).

groove, widest at base, narrowing anteriorly to rounded point; subsophageal ganglion darkly pigmented. Maxillary palpus 3.2–4.0 times as long as basal width. Inner subapical ridge of mandible with single sensillum proximal to 1 large, subtriangular serration. Lateral plate of thoracic proleg moderately well sclerotized, about as long as wide, extending almost length of apical article. Body (Fig. 15) gradually expanding posteriorly, dark gray and white, piebald, lacking conspicuous cuticular setae; pigmentation heaviest on dorsum of segments 5–7 (often forming a triangle with apex pointing anteriorly), and on thorax; gonadal sheath darkly pigmented in male (often visible through integument), unpigmented or pigmented posteriorly in female. Anterodorsal arms of anal sclerite broadly connected to,

broader than, and about  $\frac{1}{3}$  shorter than posteroventral arms. Rectal setulae short, sparse, visible only under phase contrast. Posterior proleg bearing 18–22 hooks in 92–100 rows. Anal papillae of 3 compound lobes.

Pupa.—Length 3.3–4.5 mm ( $\bar{x}$  = 3.9 mm,  $n$  = 15). Head projecting downward, with many minute granules as on thorax; antennal sheath of female extending nearly to posterior margin of head; antennal sheath of male extending about  $\frac{1}{2}$  distance to posterior margin of head. Gill short, about  $\frac{1}{3}$  length of pupa, consisting of 9 filaments; base extremely short, immediately giving rise to 4 short-petiolate pairs of filaments plus a single filament that curves ventrolaterally and often wraps around head; filaments moderately thin, tapering, weakly

annulate; surface sculpture of base weakly differentiated (Fig. 16). Thorax with numerous, irregularly spaced, minute, rounded granules (Fig. 17); trichomes simple, moderately long, slender, rather dark, 7 on each side of thorax. Tergite I with 1 pair of setae; tergite II with 4 stout, anteriorly directed setae and 3 smaller setae on each side of midline, plus 3 setae laterally per side; tergites III and IV each with 4 anteriorly directed hooks on posterior margin on either side of midline, 2 small setae between and anterior to 2 outermost hooks, and 3–4 small setae laterally per side; tergites V to VII bare or with 1 minute seta each; tergite VIII with 3–6 hook-like setae along anterior margin on each side of midline, plus 2 minute setae per side and numerous comb-like microspines laterally; tergite IX with pair of very short, stout, slightly curving, dorsally directed terminal spines, and numerous comb-like microspines. Pleural membrane of segments II to VII with 0–1 minute setae per side. Sternite III with pair of fine setae; sternite IV with 2–3 heavy, anteriorly directed setae and 1–2 fine setae per side; sternite V with pair of stout, anteriorly directed setae and 2 fine setae per side; sternites VI and VII with pair of long, anteriorly directed, hook-like, simple or bifid setae and 1–2 fine setae per side; sternites VIII and IX generally lacking setae; sternites III to VIII with numerous rows of extremely fine, comb-like microspines. Cocoon boot-shaped, covering entire pupa and gill, very coarsely woven (especially anteriorly).

Female.—Generally grayish pruinose, with black markings on thorax and abdomen; pile silver, more golden centrally on thorax. Length: body, 2.5–2.9 mm ( $\bar{x}$  = 2.8 mm,  $n$  = 7); wing, 3.3–3.7 mm ( $\bar{x}$  = 3.4 mm,  $n$  = 7).

Frons gray, at vertex about 1.5 times broader than at narrowest point, about  $\frac{1}{3}$  width of head, with decumbent, silver pile. Clypeus gray, slightly wider than long, with silver pile. Occiput with long, silver pile reaching posterior margin of eye; postocular

setae black. Antenna with fine silver pubescence; first flagellomere longest, slightly longer than pedicel; scape and pedicel yellowish brown; flagellum dark brown. Mandible with 33–35 serrations. Lacinia with 26–27 retrorse teeth. Palpus dark brown, with stout, brown setae; palpomere V 1.9–2.3 times as long as III. Sensory vesicle located posteriorly, occupying about  $\frac{1}{2}$  of palpomere III, opening directly to exterior through rounded, expanded mouth (neck extremely short or lacking). Median proximal space of cibarium broadly U-shaped, lacking armature.

Postpronotum and proepisternum gray, with long silver pile. Scutum gray to grayish black, with 3 fine, black vittae running longitudinally, and with black patch anterodorsal to wing base; pile recumbent, silver, becoming golden centrally; humeral angle yellowish gray. Scutellum dark brown to grayish black, with long, mixed silver and brown pile. Postnotum dark brown. Anepisternum and katepisternum dark brown, with gray pruinosity; membrane and mesepimeron slightly paler; mesepimeral tuft of long, silver setae. Wing veins pale yellowish brown. Setae on stem vein and costal base mixed brown and silver; setae on other veins brown; subcosta setose ventrally; fringes of calypter and alar lobe silver. Halter tan to pale yellow, with line of fine, pale golden pile. Legs brown, often with paler patches, especially on hind basitarsus; pile primarily silver, brown on tarsi; hind basitarsus 6.4–7.7 times as long as greatest width; calcipala small; pedisulcus deep; claws simple, moderately curved.

Abdomen gray, with segments 3–5 black dorsally and segments 3–7 (sometimes 2) with small, partially shiny, brown patches laterally; sclerites of segments 6–9 dark brown, with gray pruinosity, and sparse, silver pile; sternite 7 with long, brown setae along posterior margin. Basal fringe of very long, silver pile. Anal lobe brown, shiny, subrectangular in lateral view, with ventral margin rounded, and with dorsal finger-like

extension nearly as long as body of lobe. Cercus subrectangular, about twice as broad as long, posterior margin straight, corners well rounded. Hypogynial valve a short truncate lobe, space between lobes rather broad, subrectangular. Genital fork (Fig. 13) with stem moderately long, slender, expanded at anterior end; lateral arms narrow, forming suboval to subtriangular space between them, posterior areas expanded into subrectangular plates. Spermatheca rather small, subspherical, with cuticular microspines.

Male.—Generally velvety black, with golden and brown pile. Length: body, 2.7–3.5 mm ( $\bar{x}$  = 3.0 mm,  $n$  = 5); wing, 2.9–3.1 mm ( $\bar{x}$  = 3.0 mm,  $n$  = 7).

Frons and clypeus with golden-brown pile. Occiput with long, erect, brown pile. Antenna brown, with fine, pale golden pubescence; pedicel pale brown. Palpus brown, with brown pile; palpomere V 2.5–2.7 times as long as palpomere III. Sensory vesicle oblong, about  $\frac{1}{4}$  length of its segment; neck short, opening to exterior through rounded mouth.

Postpronotum and proepisternum brown, with long, silver pile. Scutum velvety black, with pair of silvery patches extending from humeral angle posteromedially, and with silvery patch posteriorly, humeral angles pale brown; pile recumbent, golden. Scutellum dark brown, with mixed brown and golden pile. Postnotum dark brown. Anepisternum, katepisternum, and membrane dark brown; mesepimeron dark brown, paler centrally; mesepimeral tuft of silver or pale golden pile. Wing veins pale gray to yellowish brown. Setae on stem vein and costal base dark brown; setae on other veins brown; fringes of calypter and alar lobe brown. Halter dark brown basally, tan to yellow distally, with fine, brown pile. Legs brown, with paler patches, especially on hind basitarsus; pile brown to golden brown. Hind basitarsus 4.9–5.0 times as long as broad; calcipala small; pedisulcus deep.

Abdominal tergites velvety black, with

reflective, silver patches laterally on segments 2, 6, and 7, and minimally on 8; pile brown to golden brown; membranous areas grayish, with long, brown and golden brown pile; sternites brown, with brown pile. Basal fringe of long brown to golden brown pile. Terminalia as in Fig. 14. Gonocoxite about 1.5 times longer than broad, with ventrolateral angle produced posteriorly. Gonostylus narrow, rounded apically, about as long as gonocoxite, 3.6–3.7 times as long as basal breadth, lacking apical spinule. Ventral plate finely setose, in ventral view deeply and broadly incised posteromedially, about 1.5 times broader than long, with lateral margins somewhat parallel and anterior margin smoothly convex; arms short, with apices curving inward; lip in terminal view with three, subequally prominent lobes; median sclerite elongate, triangular; paramere in lateral view subquadrate basally, narrowing distally, and bearing numerous, variably long, spine-like processes.

Chromosomes (from larval salivary glands; Bedo 1975).— $n$  = 3; chromocenter absent; pseudochromocenter (ectopic pairing) occasional; B chromosomes lacking; centromere regions of all chromosomes expanded, each bearing sharp centromere band (that of chromosome III included in heavily staining heterochromatic area of expanded region); all chromosome arms standard for *S. pictipes* group; IIL as sex chromosome, with females homozygous for heavy band at 63A4 and males heterozygous for heavy and thin band at 63A4; floating inversions lacking.

Types.—Holotype: ♂ (pinned) with pupal exuviae and larval head capsule (in glycerin), Sixteenmile Creek, junction of Washington Street and Shadduck Road, Northeast (town), Erie Co., Pennsylvania (42°11'N, 79°50'W), 10 August 1988, collected by P. H. Adler and C. R. L. Adler. Paratypes: same data as holotype, 174 larvae (including 40 mature), 10 chromosome preparations (6 female larvae, 4 male larvae) with photographic negatives, 36 pupae,



91 pupal exuviae, 24 ♂ (pinned) with exuviae (in glycerin), 2 ♂ (cleared, in glycerin), 2 ♂ (in alcohol), 25 ♀ (pinned) with exuviae (in glycerin); same data as holotype, 5 August 1986, 36 larvae, E. C. Masteller; ARKANSAS: MARION COUNTY: same data as holotype, 12 August 1989, 36 larvae (including 20 mature), 42 pupae. Georges Creek, junction of Rt. 62, 6 km west of Yellville, 24 April 1989, 9 larvae (including 1 mature), 5 pupal exuviae, P. H. Adler and C. R. L. Adler.

Additional specimens examined.—PENNSYLVANIA: ERIE COUNTY: Fourmile Creek, Wesleyville, near Behrend Campus, 12 May 1983, 1 chromosome preparation (female larva), E. C. Masteller.

Etymology.—The specific name is derived from the Latin *clari* meaning clear, and *centrum* meaning center, in reference to the clearly defined centromere bands that readily distinguish this species from closely related taxa.

Diagnosis.—Larvae (later instars) of *S. claricentrum* can be distinguished from those of other members of the *S. pictipes* group by the piebald pigmentation of the body and the paler head capsule; earlier instars are more uniformly dark. The nine-filamented gill of the pupa lacks the tuberculate surface sculpture on the basal  $\frac{1}{4}$  to  $\frac{1}{3}$  of each filament, unlike other members of the *S. pictipes* group. The female cannot be reliably distinguished from that of *S. pictipes*. The ventral plate of the male is about 1.5 times as broad as long, with somewhat parallel lateral margins; in *S. pictipes* Hagen the ventral plate has divergent lateral margins, and in *S. longistylatum* Shewell it is nearly as broad as it is long. Chromosomally, the species is most easily identified by the presence of well-defined centromere bands (Bedo 1975).

Biology.—Like other members of the *S. pictipes* group, the immatures of *S. claricentrum* are often found in moss-like clumps in swift watercourses. In the Lake Erie drainage basin of Pennsylvania, *S. claricen-*

*trum* was found where water spilled over small shale-bottomed waterfalls, but in one case was found on a coarse cement sluiceway. These streams ranged in width from 10 to 20 m and in temperature from 16 to 27°C. In Oklahoma, *S. claricentrum* was collected from limestone streams with smooth, travertine substrates (Reisen 1974a, 1975a); larval abundance was highest during the spring months and was positively correlated with periphyton abundance (Reisen 1977). The Oklahoma streams ranged in temperature from 17 to 29°C, in pH from 7.7 to 8.2, in alkalinity from 235 to 250 ppm, and in dissolved oxygen from 7.5 to 8.5 ppm (Reisen 1974b, 1975a). In Arkansas, immatures were taken from a calcareous siltstone-bottomed stream approximately 10 m wide, with a temperature of 23°C. *Simulium claricentrum* is multivoltine, immatures having been collected from early May through August in Pennsylvania and year round in Missouri and Oklahoma (Bedo 1975, Reisen 1974a, 1975a, b). The species passes through six larval instars (Reisen 1975a). In 1989, I found a mixed population of *S. pictipes* and *S. claricentrum* in Sixteenmile Creek, Pennsylvania. About 5% of *S. claricentrum* larvae in Sixteenmile Creek (1989) carried patent infections of the microsporidium *Polydispyrenia simulii* (Lutz and Splendore), formerly known as *Pleistophora multisporea* (Strickland) (Canning and Hazard 1982).

Reisen (1974a) recorded mating swarms at the base of riffles; coupled pairs immediately dropped to the ground where copulation lasted only a matter of seconds. Females oviposited from 200 to 400 eggs in dense masses during the early evening hours on rocks, grasses, algae, and mosses splashed with water (Reisen 1974a).

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vania collection of *S. claricentrum*, as well as several subsequent larval collections. F. F. Hunter scored three slides of *S. fionae* for polymorphisms. A. H. Undeen identified the microsporidia. C. I. Dial and J. P. Norton rendered the illustrations, and J. R. Brushwein and J. D. Culin photographed the larvae. C. R. L. Adler and J. C. Morse reviewed the manuscript. To all of these individuals I extend my thanks. This is Technical Contribution No. 2975 of the South Carolina Agricultural Experiment Station, Clemson University.

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